

## IMIS Report No. 4: Bulgaria

July 1994

### A Tutorial on Geographic Information System (GIS) Implementation for Bulgarian Municipalities

As the system of local government evolves in Bulgaria, municipal officials face new responsibilities and challenges. This monograph is intended to be used as a primer on GIS concepts and implementation issues for municipalities in Bulgaria. It is a general guide applicable to all municipalities, recognizing that those with populations of 80,000 and above generally have the greatest need and are in the best position to reap considerable benefits from the technology. GIS may be used to address problems that are critical for managing developed urban land and non-developed land inside a municipality's boundaries. The report was prepared by the International City/County Management Association (ICMA). Funding for this report was provided by the United States Agency for International Development (USAID).

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### Contents

#### Tutorial on Geographic Information System (GIS) Implementation for Bulgarian Municipalities

ICMA is working with cities throughout Bulgaria on practical problems and issues. Current work is underway in the areas of housing development, municipal finance, water conservation/infrastructure maintenance, and geographic information systems. This report is based on the work carried out in Bulgaria by ICMA consultants Peter Croswell and Yordanka Zaharieva. This report was funded by USAID under the Local Government and Housing Privatization Project for Central and Eastern Europe (Contract No. EUR-0034-C-00-2034-00, Request for Services #46). ICMA is grateful to Mayor Eliana S. Maseva of Blagoevgrad and her staff for their collaboration on a pilot GIS project for Bulgarian cities.

#### Importance of GIS for Municipal and Regional Governments

The programs and activities of municipal governments in Bulgaria are primarily dependent on information that is geographically referenced. Municipal departments are in charge of responding to the needs of their citizenry as they relate to geographically dispersed land use, public facilities, and infrastructure. The fundamental tenet guiding GIS development is greater coordination in the management of geographic information. A reduction in redundant collection and storage of information, greater consistency in that information, and better mechanisms to deliver the information to users will have long-term benefits to government organizations and outside users. These benefits are dependent, in large part, on better coordination between departments within Bulgarian municipalities and coordination with regional government agencies with which municipalities exchange information. In addition, coordination with national ministries is important because certain ministries have key roles in setting standards for mapping and geographic information collection. A final piece of the puzzle in an overall municipal GIS program is cooperation and partnerships with utility companies and private companies, such as banks, which have a strong need for geographic information.

A properly designed and implemented GIS can provide the following benefits, some of which may be measured in terms of actual financial savings or increased productivity of staff. Other benefits are more difficult to measure but often add important justification for proceeding with GIS implementation. These benefits may be categorized as follows:

**Reduction in staff time** spent on current municipal programs and activities involving the updating and production of maps and databases, the retrieval and verification of geographic information, and the completion of special studies and projects requiring geographic information analysis.

**Information security and protection against catastrophic loss** of valuable maps and records in the event of a fire or other disaster.

**Avoidance of new staff and overhead costs** associated with new municipal programs (e.g., more intensive property appraisal programs) that might otherwise be required without the use of GIS.

**Avoidance of facility costs** associated with remedial maintenance or replacement or duplicative work on utility facilities (e.g., water, sewer, electric) that could have been avoided through better coordination with information from the GIS.

**Actual cost savings** on large engineering contracts. Planning and design work for infrastructure development projects (e.g., roads, water, sewer) require a considerable amount of geographic information. Map information accessed directly from a GIS can reduce the need for expensive field data collection and verification.

**Cost recovery from sale of GIS products** including standard or custom maps and reports and direct database access by private companies.

**Improvement in the quality and timeliness** of services provided to the community.

Improved ability to **respond quickly to emergency situations** where GIS offers up-to-date spatial information, making rapid analysis and response possible.

The rapid transition to a market-based economy in Bulgaria has direct impact on land transactions and development. In particular, creation of a land market requires that up-to-date information about the characteristics of land parcels (size, location, improvements, etc.) be made available quickly. A healthy land market is also dependent on the ability to determine current and historical ownership, use, and sales history as a basis for establishing the value of a property. GIS provides the tools to collect, store, and retrieve this information quickly. In large urban areas, the long-term financial returns from routine land transactions may be justification enough to invest in GIS. A sound base of up-to-date geographic information with a system to deliver it quickly is an impetus to land development and an essential requirement for support of the privatization process.

## Important GIS Concepts

### What is GIS?

As a computer technology, GIS is a tool which is not fundamentally different in concept from other automated systems that municipalities operate. It is unique, however, in its capabilities to store, plot, relate, and actually analyze multiple map layers (graphic) information as well as tabular (non-graphic) information connected to those maps. As such, GIS offers “geographic intelligence” not possible with traditional automated systems or even automated mapping systems. GIS is also unique because it is a tool whose applications cross departmental lines: it implies the integration and coordination of many different types of municipal information related to geographic areas. Geographic information is fundamentally important to nearly all municipal and regional governmental offices. Because of this, GIS can be an impetus to greater integration of City operations with corresponding increases in consistency and efficiency and reduction in redundancy of information collection and management.

In a broad sense, a GIS consists of three main components. These three components include the physical system (hardware and communication network) on which the GIS operates, the geographic database, and the people who use it.

### GIS Hardware and Networks

GIS uses computer systems very much like those used for other municipal computer applications. The main difference is that GIS is used to view and analyze spatial information, and therefore it places a greater emphasis on graphic display devices and various types of plotting devices to generate hard copy maps in color and black and white. Commercial GIS vendors have adopted a computer configuration model known as “client-server networks” on which to implement their software. The client-server network, depicted in general form in Figure 1, includes one or more computers called “servers” to store common data which is accessible to all users on the network through workstations or “clients.” These servers and clients may be microcomputers like those already in use in many Departments, or they may be more powerful computers that use an operating system called UNIX. Regardless of the type of computers in use, the GIS client-server network is designed to provide high-speed and efficient access to a centrally managed database.

Figure 1 Client-Server Network

### GIS Database

Map information stored in a GIS can be conceptualized as a series of map “layers” (see Figure 2). These map layers consist of spatial data (map features) such as parcels, buildings, utility lines, etc., all of which are referenced to a common coordinate system. These features are linked to tabular attribute data allowing cross-referencing, querying, and advanced spatial analysis.

Figure 2 GIS Database Layers

### GIS Organizational Issues

The technical issues discussed above involving hardware, software, and databases are central to the development of a useful GIS. However, the most critical aspects of GIS development--and the ones that often determine the success or failure of a system--are the organizational structure and procedures. These organizational issues will be discussed in more detail later in this monograph.

### GIS Applications

The objective in GIS implementation is to facilitate, improve, and make more effective the users’ day-to-day management, planning, analysis, and decision making. The products that achieve these goals may be updated maps, hard copy reports, displays on computer screens, graphs which summarize the results of geographic analyses, or other output that can be generated from the system. A GIS application is a set of instructions to the computer system that sets up a flexible user interface and directs the system to generate certain products such as hard copy or screen displays of maps or reports. The potential list of applications for

which GIS may be used by the municipality is nearly endless, but almost all applications can be generalized into the following four categories:

Standard Map and Database Update and Production

Geographic Query and Custom Map Display

Geographic Reference to More Detailed Information

Spatial Analysis.

Standard Map and Database Update and Production

Bulgarian municipalities and utility companies routinely maintain and use maps with standard scales and formats showing land parcels, physical features (buildings, streets, etc.), utility lines, and other features. Keeping these maps and associated tabular attribute information up-to-date is cumbersome when manual methods are used. Producing copies of these maps, particularly when scale and format changes are needed, is equally difficult when done in a manual environment. Geographic data should be considered a strategic investment. GIS provides tools that keep automated maps and associated attribute information up-to-date so that this information maintains its value for the municipality. Through such data entry techniques as interactive digitizing and scanning, geographic databases may be maintained in a routine basis as business is transacted by the municipality. GIS map display and production capabilities can greatly increase the efficiency and flexibility in producing needed map products.

Geographic Query and Custom Map Display

Perhaps the most powerful capability of GIS is its ability to automatically create map displays of geographic information based on questions by users. This capability for “visualizing” geographic information can be used for any type of data that is included in the GIS database. The GIS can create custom displays in a format that best suits the needs of users. Figures 3a to 3c illustrate some general examples of this category of applications.

Query and custom map display applications can be used to analyze property characteristics as a basis for assessing land value. GIS is being used by local property assessment offices in the US and Canada to analyze neighborhood characteristics property values and land sales. GIS is one tool that can help Bulgarian municipalities as they work toward instituting a more active land market and consistent taxation system. Another possible query/display application of GIS is to support planning by telecommunications companies in extending their communication networks and offering a fuller range of communication services. Decisions on how and where to expand are largely financial, requiring an analysis of the location of potential customers. A GIS may be used to spatially examine ownership and

demographic information as a tool for decision support and planning. Municipalities around the world, including some in Eastern Europe, are applying GIS capabilities to promote tourism. Electronic “kiosks,” with easy-to-use interfaces for map query and display, can be used to give visitors information about tourist sites and events.

### Spatial Index to More Detailed Information

Municipal agencies collect and store many types of documents and records about land, buildings, and utility facilities which are geographically referenced but for which entry into a traditional map layer database is not appropriate or feasible. For example, detailed engineering construction drawings and card files may provide detailed information about features of the water or sewer networks; floor plans and wiring diagrams associated with public buildings may be maintained in paper files; and formal certificates maintained by the public notary that document ownership titles to land and buildings are associated with specific land parcels. These records can be referenced to specific locations or features within GIS map layers. The GIS can then be used as a spatial index to identify the existence and file location of those records. It is even possible to optically scan those records and store the images in a database for interactive retrieval directly from the GIS.

### Geographic Analysis

GIS software also has powerful capabilities to perform spatial analysis of geographic information to answer questions more complex than the simple queries described in the categories above. For instance, GIS software may be used to analyze linear networks to assess traffic volumes or to model the flow in water distribution lines. Geographic analysis capabilities can also support complex area analysis such as determining the suitability of sites for development, as illustrated in Figure 4. This type of application has particular benefit when a municipal government is seeking investment from private sources (domestic or foreign) for major commercial or industrial development projects. Easily accessible information about the land, property ownership, demographics, etc.--and the ability to combine this information for analysis--can encourage and expedite decisions to initiate such development projects.

### Figure 4 Suitability Analysis Using Map Overlays

### Evaluating Needs and Implementing the GIS

#### GIS Development Steps

GIS development should follow a logical process that may be divided into the following principal stages:

Definition of Needs (hardware, software, data, staffing, training)

Analysis of Institutional Environment, Policy Issues, Needs, and Constraints

Conceptual Design and Implementation Planning

Detailed System Specification and Procurement

Establishment of a Management Structure and Institutional Procedures

Prototype Implementation

Full Implementation.

Various steps within each of these stages lead to actual installation and operation of the GIS.

Table 1 characterizes the activities and results from the initial needs assessment through the prototype implementation. Needs assessment and analysis of the institutional environment rely heavily on interviews and collection of information through survey forms from participating organizations. This analysis has the ultimate goal of defining a set of potential GIS applications that respond to the municipality's activities. A description of the applications, including the requirements for hardware, software, and databases, sets the stage for subsequent phases in the development process.

The conceptual design and implementation planning stage defines long-term phases for system development and defines the basic physical layout of the GIS. An implementation plan is then created which defines detailed tasks leading to full operation along with an anticipated schedule and assignment of responsibilities for carrying out the tasks. Costs for all aspects for system development are tabulated in this stage and, optionally, attempts may be made to quantify benefits by examining staff hours, current expenditures, and other measures. Following the conceptual design, detailed specifications concerning the content and format of the database and the performance requirements of the hardware and software are defined. Many organizations elect to use these detailed specifications in a competitive tender for the selection of products and services from outside firms. System implementation should be preceded by putting in place a proper management structure and institutional procedures for effectively running this multi-Departmental effort.

The prototype stage should be considered the first actual development step toward full implementation. It is used as a basis to test procedures and technical specifications for final revision before full implementation is launched.

Organizational Issues

Institutional Challenges

The ability of the organizational structure to make use of GIS technology directly impacts the benefits that can be derived from GIS. The GIS organizational structure must be able to respond to the following types of institutional challenges if the GIS is to be used effectively:

**High-level policy decision-making and consensus** including decisions about assignment of staff, funding, relationships with outside organizations, data access privileges, assignment of responsibilities for data update, setting, etc.

**Routine system management** including operation of hardware/software, technical support to users, design and development of applications, and management of contracts for hardware, software, or database services.

**Standards development and coordination** including development of standards associated with hardware, database, and applications and development of procedures to ensure that all users comply with these standards.

**Responding to information requests** from municipal users and outside parties including the creation of procedures and design of products for meeting requests from the user community.

#### Organizational Components

Experience in North America has shown that an organizational structure best positioned to meet these challenges should consist of four components: a policy body, a management unit, Department coordinators, and technical work groups, each of which is described in more detail in Table 2.

#### Participation

Senior management representatives from all participating departments and outside organizations.

A GIS manager with small technical staff for system administration, database administration, applications development, and technical support to users.

Normally, one or more mid-level management or technical staff people in the Department are assigned as coordinators.

Open to any staff members with interest and expertise on technical development and operation issues.

During the system development (through the prototype stage) at least two of these components should be formally put in place: the policy body and a technical work group. A formal management unit (as a separate administrative body) is not absolutely essential during this part of the process, but a **GIS project manager and some technical staff should be assigned full or part-time**. After the prototype stage, all four components should be put in place.

A critical decision at this point is the organizational placement of the management unit. To operate effectively, this group must be able to easily communicate with and coordinate activities among multiple departments and organizations. Also it must have the authority to impose standards and operating procedures on the user agencies. The management unit could be placed within an existing Department in the municipality or regional government, a new formal organizational unit could be created, or an independent unit (not directly attached to the municipal government) could be assigned management unit responsibilities. The decision on organizational placement is influenced by the nature of the relationship between the municipal authorities and regional government authorities. There are many long-term benefits from joint municipal-regional GIS coordination. Under such a scenario, a reasonable option may be to create a new, independent management unit that can respond to all users in municipal and regional agencies as well as private firms. Such an organizational structure is depicted in Figure 5.

#### National Focus on GIS Activities

Successful GIS implementation in Bulgarian municipalities will be aided by close coordination with national ministries involved in mapping and geographic information management. Several national agencies, the most important of which are the Central Cadastre Office, the Ministry of Territorial Development and Construction, and the Ministry of the Environment, have established guidelines for mapping and geographic information collection and have some experience in the use of GIS software. As municipal GIS activities mature in Bulgaria, coordination at a national level can help to provide “template” specifications and models to avoid multiple municipalities “re-inventing the wheel.” Municipalities in Bulgaria have some advantages in GIS implementation over their counterparts in the US. In Bulgaria there is a strong national focus driving standards for municipal information collection and mapping, programs for property information and transactions, and land surveying. The US has only recently begun to coordinate geographic information programs through the federal government’s promotion of the National Spatial Data Infrastructure (NSDI). The fact that a foundation for national geographic information standards is already in place in Bulgaria provides advantages for GIS development among multiple municipalities.

## System Costs and Relationship with Outside Vendors

### GIS Implementation Costs

Initial costs for GIS implementation can be quite high. The most significant costs fall into the following categories:

**Hardware and software**, including the initial purchase of hardware, software licenses, communication networks, and on-going maintenance and support costs.

**Staffing**, which may involve additional expenditures if GIS staff support will require hiring new positions.

**Database development**, including costs for updating and “cleaning up” existing records and the creation of the GIS database from current maps, new data collected from the field, or aerial photography. Costs for database development are highly variable depending on the detail and accuracy of digital maps, the condition and reliability of existing source documents, and the level of use of existing in-house staff.

Because of the variable factors in size and local conditions among municipalities in Bulgaria and the specific design options that may be exercised by the municipalities, it is difficult to generalize on the cost of system development. For a typical city covering 200 square kilometers, with a population of 250,000, and with existing maps and records that are in reasonably good order, the following cost ranges, spent over a four-year development period, are representative of costs experienced by municipalities in the US:

Hardware and Software: \$700,000 to \$1,700,000.

New Staffing: \$175,000 to \$300,000. (Represents additional staff hired for GIS, at US salary levels.)

Database Development: \$1,200,000 to \$2,300,000. (Represents contract costs with the assumption that the majority of database development is done by a private firm. Costs would increase with the need for more field work, data validation, and map compilation resulting from limitations of existing paper records.)

### Vendor Relations

Private contractors and vendors will undoubtedly have a key role in providing products and services for the GIS. In Western Europe and North America, there is an established industry for providing GIS hardware and software. Most government agencies base their selection of hardware and software vendors on a competitive process in which the vendors respond to formal “request for proposals” or “tenders.” These responses may be followed by

benchmark tests in which the capability of the system is demonstrated. Selections are made by an evaluation of technical, cost, and support issues. Since GIS implementation in Bulgaria is not yet mature, considerable weight in vendor selection should be given to the level of hardware maintenance and software support that the vendor can provide. A procurement of GIS services should be made through a formal contract that defines all products and support services, prices, delivery schedules, etc. Most vendors will have standard form contracts defining all terms. These may be used as a basis for preparation of a standard contract which may best be developed by a national ministry as a suggested contract template for all municipalities in Bulgaria.

In North America, and to a lesser extent in Western Europe, there are many established companies that provide services for GIS database development including aerial photography, base map compilation, digitizing, scanning, etc. None of these firms has established a business base in Bulgaria or surrounding countries. In the short term, database development services may best be provided locally with service centers established by municipalities or regional authorities in association with national ministries, universities, and private engineering firms. Technical support from North America or Western Europe would help to accelerate development of service centers.

#### Information Access and Cost Recovery for GIS Products and Services

There is great interest on the part of municipal governments in the US and Canada to collect outside revenue by selling products and information from their GISs. It has become apparent that there is a high demand for GIS products and services from government agencies. The clients, most of whom are willing to pay reasonable fees, include utility companies, banks and mortgage companies, real estate developers, engineering firms, and other parties.

Municipal government experience in the US suggests that revenue may be generated by offering for sale one or more of the following products or services: (a) subscriptions to (licenses to use) the GIS database, (b) custom hard copy maps and reports, (c) custom digital files covering project areas, and (d) on-line access to the GIS.

While the relationship between private companies and government in Bulgaria and the legal foundation governing these relationships is different than in the US, opportunities for revenue generation and cost sharing opportunities exist. Where possible, cost sharing agreements between the municipality and other organizations (e.g., utility companies, banks) should be established at the early stages of system development. During system operation additional opportunities for sales of data and products should be aggressively pursued. Fees for access to information and products should be set low enough so that a large user community may be served and GIS activities are encouraged rather than stifled.

A side benefit of more accessible geographic information may be the spawning of support industries including those specializing in consulting, data conversion, and a “value-added re-selling” of products and services using municipal GIS data. This has been the experience in North America and Western Europe as GIS has matured over the past decade.

#### When and How to Proceed with GIS Implementation

GIS provides tools that are potentially useful to any municipality, but the technology is not appropriate for some--at least in the short term. Positive answers to a majority of the questions below likely indicate that the risks are within reason and opportunities for benefits from GIS are high:

Does the total number of parcels within the urban area exceed 40,000?

Are there good prospects for a vigorous land market to emerge in the near future?

Are current municipal maps up-to-date and legible?

Are there any major land development or construction projects planned which could be a stimulus for initiation of GIS?

Have utility organizations and private companies (e.g., banks) expressed an interest in better geographic information and might they be willing to help fund a development effort or purchase products or data from the municipality?

Are computers currently used in the municipal departments and utility companies and is there a reasonable level of understanding about the value of automation?

Are there existing procedures, standards, or plans encouraging sharing of information among multiple departments or other major automation efforts in the works?

Is there a university or technical school in the vicinity with programs in mapping, computer science, or related disciplines?

A decision to proceed with GIS is largely dependent on the level of interest, motivation, and willingness to adopt new approaches on the part of key municipal managers and staff.